

**Before the  
FEDERAL COMMUNICATIONS COMMISSION  
Washington, D.C. 20554**

In the Matter of

Revision of Part 15 of the Commission's Rules to                      ET Docket No. 13-49  
Permit Unlicensed National Information  
Infrastructure (U-NII) Devices in the 5 GHz  
Band

**Via the ECFS**

**COMMENTS OF IEEE 802**

1. IEEE 802<sup>1</sup> respectfully submits its Comments in the above-captioned Proceeding<sup>2</sup>.
2. IEEE 802, as a leading consensus-based industry standards body, produces standards for wireless networking devices, including wireless local area networks ("WLANS"), wireless personal area networks ("WPANS"), wireless metropolitan area networks ("Wireless MANs"), and wireless regional area networks ("WRANS"). Included in our standards development activity is an emphasis on coexistence, which is the focus of our Wireless Coexistence working group. We appreciate the opportunity to provide these comments to the FCC.

**PREFACE**

3. On February 20, 2013 the Commission issued a Notice of Proposed Rulemaking, under ET

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1 The IEEE Local and Metropolitan Area Networks Standards Committee ("IEEE 802" or the "LMSC").

2 This document represents the views of IEEE 802. It does not necessarily represent the views of the IEEE as a whole or the IEEE Standards Association as a whole.

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Docket 13-49, in which the Commission seeks comments on revision of the rules for the 5 GHz U-NII band and other related matters.

4. IEEE 802 has already published standards and is in the process of completing additional amendments to standards which support operation in the U-NII band under Commission's Part 15 rules for operation of U-NII band devices.

### **EXECUTIVE SUMMARY**

5. IEEE 802 thanks the Commission for opening this proceeding, and for doing so with an expansive set of questions that can serve to help industry update and improve 5 GHz radio local access network (RLAN marketed as "Wi-Fi") technologies. IEEE 802 includes several hundred people who participate individually in the standards-setting process, many of whom are employed by leading technology companies. IEEE 802 is uniquely positioned to comment on the technical matters raised in this proceeding, as this is the global standards body for both commercial Wi-Fi and technology that is the candidate to become "Dedicated Short Range Communications" for vehicular safety.
6. IEEE 802 agrees with the FCC that the growing demands being placed on Wi-Fi technologies, and the evolution of the technology itself to deliver an improved user experience, warrant a close examination of the regulations for sharing the 5 GHz band with 802.11 commercial devices, with a strong focus on whether a contiguous band of spectrum can be identified to support next generation radios. IEEE 802.11ac technology, using channels of 80 or 160 megahertz wide, is already being introduced into devices that consumers and businesses use to connect to the Internet or to move data, and that adoption is expected to continue to rise steeply in the coming years. Having spectrum available that would allow up to nine 80-megahertz wide channels or four 160-megahertz channels will ensure that the technology can meet the foreseeable demands being placed on its by users, which today include consumers, businesses and service providers.
7. To support the continued growth of this industry, IEEE 802 recommends that the FCC take the following actions or implement the following approaches to resolving the large number of issues raised by this Notice:

- Identify and group issues into modules that can be resolved relatively quickly, as well as those that will need more time to resolve because they raise new or novel issues. Endeavor to resolve issues as quickly as possible to enable improved shared use of the 5 GHz band by commercial devices.
- Resolve the U-NII-2C issues in order to reopen 5600-5650 MHz to commercial use by
  - Requiring manufacturers to use improved security to ensure that software and firmware governing radio emissions is not susceptible to user tampering.
  - Adopting the revised Section 15.407 and apply it to the U-NII3 band (including 5825-5850 MHz) to guard against the types of radar interference seen to date.
  - Continue to maintain the requirements that limit user configuration of regulatory domain to ensure users do not choose a domain that lacks dynamic frequency selection sharing technology.
  - Refrain from adopting more disruptive approaches, i.e., geolocational databases, more restrictive unwanted emissions requirements or frequency separation. The rule changes proposed above, or already in use as staff guidance, fully address the interference issues seen to date with Terminal Doppler Weather Radars.
- Adopt the following rule changes as soon as possible:
  - Codify previous guidance that forbids devices allowing users to turn DFS off.
  - Require DFS to be “on” when devices are on (a potential exception for low power devices is further discussed below).
  - Introduce a spectral density requirement if devices are certifying under the the relaxed -62dBm standard for co-channel sensing.
  - Revise Bin 1 in accordance with the Notice.

- Eliminate the uniform channel spreading rule, which is unnecessary in the era of wide channel technologies.
  - Revise the channel loading test approach to better reflect current and future loading of devices during the DFS test.
  - Miscellaneous rule changes proposed in the Notice.
  - The 12-month transition period from the effective date of rules to the application of the new rules to new certifications.
  - Add 5825-5850 MHz to the U-NII rules.
- Examine and adopt additional rule changes:
  - Examine if there could be a low power exemption to DFS.
  - Harmonize the U-NII-1 rules to match the U-NII-2A rules, including elimination of “indoor only” requirements.
- For U-NII-4, assist industry in determining if there is a potential sharing solution that can protect mission-critical DSRC automotive uses, and other uses of the band, and if so, ensure that the solution is thoroughly tested, certification rules are drafted and examined by all stakeholders, including potentially testing the certification rules to see if the rules work and yield predictable outcomes. If a sharing case can be made based on this process, promptly adopt certification rules.
- For U-NII-2B, assist industry in examining the analyses produced by NTIA to determine if there is a potential sharing solution that can protect government systems operating in the band, and proceed as for U-NII-4, above, to determine if an actual solution can be developed and tested to the satisfaction of stakeholder

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## **I. Introduction**

8. IEEE 802 is pleased to provide comments on the Federal Communication Commission's Notice of Proposed Rulemaking in the above-captioned proceeding.<sup>3</sup> This contribution was developed by the IEEE 802.11 working group of IEEE Project 802®, the Local and Metropolitan Area Network Standards Committee ("IEEE 802"), an international standards development committee organized under the IEEE and the IEEE Standards Association ("IEEE-SA"). IEEE 802.11 represents the part of Project 802® that develops standards for Radio Local Area Networks (RLAN) which today serve an important role in delivering wireless broadband in residential, enterprise, and public locations throughout the United States and the world. In addition, RLANs today are being used by all types of service providers to deliver wireless broadband services to users.
9. IEEE 802 thanks the Commission for opening this proceeding, and for doing so with an expansive set of questions that can serve to help industry update and improve RLAN technologies. IEEE 802 includes several hundred people who participate individually in the standards-setting process, many of whom are employed by leading technology companies all over the world. IEEE 802 is the organization most familiar with RLAN standards and how standards have been evolving to address multiple issues – throughput, security, enhancements to medium access control and physical layer functions, new network topologies (such as mesh), and interoperability with other networks, to name a few.<sup>4</sup> Relevant to this proceeding, IEEE 802 is also the standards body for IEEE Std 802.11p, "Wireless Access in Vehicular Environments." This is the technology now under consideration by the transportation industry and the US Department of Transportation for use in the U-NII-4 band<sup>5</sup> for vehicular safety applications, taking advantage of spectrum allocated to the transportation sector for "Intelligent Transportation Services." As a result, IEEE 802.11 is uniquely positioned to comment on the technical matters raised in this proceeding.
10. In this comment, IEEE 802 will discuss: in Section II, our support for a broad examination of the rules for commercial unlicensed devices sharing the 5 GHz band, including the extent to which the

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<sup>3</sup> In the Matter of Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band, ET Docket No. 13-49, Notice of Proposed Rulemaking, released Feb. 20, 2013.

<sup>4</sup> IEEE 802 standards are available for free download at: <http://standards.ieee.org/about/get/802/802.11.html>

<sup>5</sup> This comment will utilize the U-NII classification system announced in the FCC's NPRM: U-NII-1 is 5150-5250 MHz; U-NII-2A is 5250-5350 MHz; U-NII-2B is 5350-5470 MHz; U-NII-2C is 5470-5725 MHz; U-NII-3 is 5725-5825 MHz (with a proposal to extend this to 5850 MHz); and U-NII-4 is 5850-5925 MHz.

FCC can provide for a contiguous block of spectrum for next generation equipment; in Section III, the importance of grouping issues and resolving those that can be resolved promptly as soon as possible; in Section IV, revisions to the regulation of the U-NII-2C and U-NII-3 bands, including improved security requirements, the application of the revised Section 15.407 and limitations on user configuration to guard against interference to Terminal Doppler Weather Radars (TDWR); in Section V, immediate rule changes to improve utility of the band and the sharing environment, including the new Bin 1, a revised channel loading test, adding 5825-5850 MHz to the U-NII rules, and many others; in Section VI(A), examination of the potential to eliminate DFS for low power devices; in Section VI(B), improving the U-NII-1 rules to align with U-NII-2A and eliminating the restriction on indoor-only; in Section VII, examining the sharing case for U-NII-4 with vehicular safety and other band users; and in Section VIII, examining the sharing case for U-NII-2B with federal systems.



## **II. New demands on commercial wireless broadband compel examination of 5 GHz spectrum utilization by RLANs**

11. In this proceeding, the FCC has raised a comprehensive list of questions relevant to the operation of RLANs in the 5 GHz bands. IEEE 802 supports this broad examination of the band, including whether existing rules are optimized for current RLAN operations, and whether additional spectrum, on a shared basis, could be made available for RLAN use. RLANs, and in particular Wi-Fi, has evolved over the past 15 years to one of the most important broadband access technologies. The consumer demands that are being placed upon it are growing rapidly along with consumer use of wireless data. The technology is now routinely embedded into nearly every smartphone, tablet and laptop sold, and will be embedded into an ever increasing number of devices as manufacturers of a range of products make the decision to connect those devices to the Internet. In the view of IEEE 802, the explosive use of this technology compels an examination of whether the amount of spectrum, as well as the technical rules for its use.
12. Commercial devices operating in the 5 GHz band are unlicensed devices. Pursuant to FCC rules, these unlicensed devices may not cause harmful interference to primary systems (e.g, government, primary, or licensed systems), and must accept all interference from those with superior spectrum rights.<sup>6</sup> Whether adjusting rules for bands in which RLANs already operate, or in creating new rules for new spectrum, it is important that the FCC and other stakeholders have confidence that use of unlicensed devices will not produce harmful interference. IEEE 802 also notes that the term “harmful interference” is not specifically defined. That is useful because what constitutes harmful interference in one situation may not constitute harmful interference in another. In the Middle Class Tax Relief Act<sup>7</sup>, Congress used the phrase, with respect to Federal systems, that “the primary mission of the Federal spectrum users...will not be compromised.” While that portion of the Act specifically references 5350-5470 MHz, it serves as a useful way to think about the task at hand – can unlicensed devices make improved and expanded use of the band without compromising the mission of the existing or planned future uses of the band by primary systems?
13. The Notice makes an observation about shared spectrum that is useful to highlight here: “We believe that responsible operation of U-NII devices is a joint responsibility of both manufacturers

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<sup>6</sup> Section 15.15 of the Commission’s Rules, 47 C.F.R. §15.15.

<sup>7</sup> Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96.

and users.”<sup>8</sup> We agree, and would add that it is also a responsibility of the FCC, the NTIA and other federal agencies, including their vendors, to work with industry to make certain that decisions taken on unlicensed device use are made on the best information possible, are thorough, and therefore provide certainty and stability in the spectrum sharing environment for all stakeholders.

14. IEEE 802 notes that there have been bumps in the road on spectrum sharing in the 5 GHz band, involving the 5600-5650 MHz band utilized by FAA Terminal Doppler Weather Radars. The cases that have been decided by the FCC to date do not involve IEEE 802 standard equipment. The cases reveal issues with frame-based equipment, particularly those deployed with high gain antennas, and often involve user manipulation of the equipment, including illegal operation of non-dynamic frequency selection (non-DFS) in bands that require DFS.<sup>9</sup> Among other things, the FCC has had to update its equipment certification rules to make certain that manufacturers do not provide user flexibility to utilize spectrum for which the equipment is not legally authorized. Industry welcomes strong FCC role here, both proactive and post hoc using its enforcement authority, to ensure against interference and to ensure that all manufacturers are on equal footing. But one fact about the cases should not be ignored - there has been no case to date where functioning DFS has not detected radar. Sharing works. Sharing radio technology can be designed that can detect and avoid other radio systems, and that technology will continue to evolve over time.<sup>10</sup>
15. The explosive rise in demand for commercial wireless services demands that the FCC examine the questions around access to spectrum and come to a determination on a band by band basis, whether sharing can be supported and how. IEEE 802 is constantly updating the standards for RLAN to prepare for future demands that are being placed on the technology. Of particular relevance to this

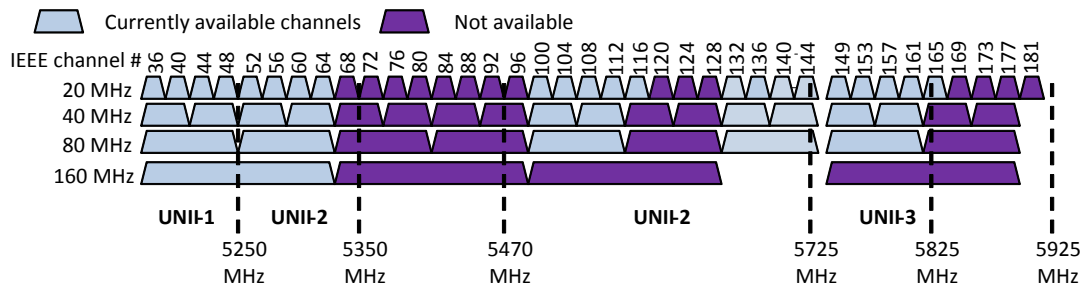
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<sup>8</sup> Notice at ¶ 70.

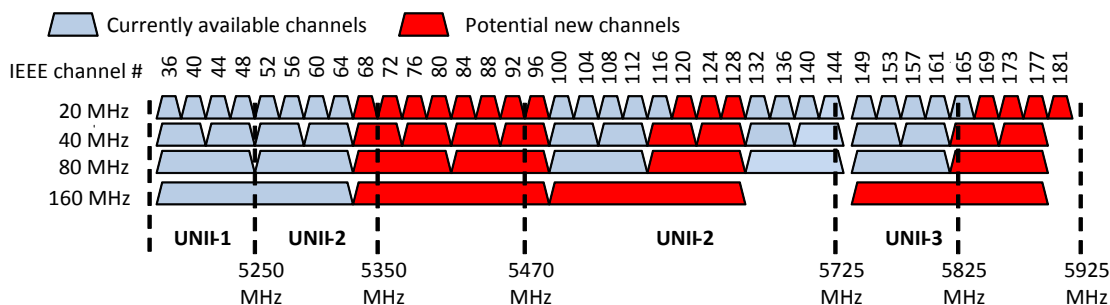
<sup>9</sup> See *VPNet, Inc.*, Notice of Apparent Liability for Forfeiture and Order, 27 FCC Rcd 2879 (Enf. Bur. 2012); *Argos Net, Inc.*, Notice of Apparent Liability for Forfeiture and Order, 27 FCC Rcd 2786 (Enf. Bur. 2012); *Insight Consulting Group of Kansas City, LLC*, Notice of Apparent Liability of Forfeiture and Order, 26 FCC Rcd 10699 (Enf. Bur. 2011); *Ayustar Corp.*, Notice of Apparent Liability for Forfeiture and Order, 26 FCC Rcd 10693 (Enf. Bur. 2011); *Rapidwave, LLC*, Notice of Apparent Liability for Forfeiture and Order, 26 FCC Rcd 10678 (Enf. Bur. 2011).

<sup>10</sup> Moreover, spectrum sensing is not the only way in which spectrum can be shared, as the Notice identifies. Sharing can be enabled by various kinds of databases, from the one now used to share federal spectrum in the millimeter wave bands [See <http://freqcoord.ntia.doc.gov/>] to the one designed to support device use in the TV white spaces band. [See Office of Engineering and Technology Authorizes TV White Space Database Administrators to Provide Service to Unlicensed Devices Operating on Unused TV Spectrum Nationwide, DA 13-324, March 1, 2013.]

proceeding is the work done on IEEE 802.11ac, an evolution of the 802.11 that utilizes broad channelization of 80 MHz or 160 MHz to deliver multi-gigabit throughput speeds, among many other improvements. At present, 802.11ac will be commercially deployed using existing spectrum. The deployment plan is as follows:



16. However, if a contiguous block of spectrum is available for 802.11ac, available channels increase, resulting in less congestion and improved quality. The number of 80 MHz channels increases from five to nine, and the number of 160 MHz channels quadruples from one to four.



17. A contiguous footprint of spectrum therefore represents an enormous gain in the ability of 802.11 RLAN devices to meet consumer demand for wireless broadband. Whether that can be achieved is the subject of this proceeding, both with respect to making new spectrum available or in improving access to spectrum already designated for unlicensed device use.

### **III. The FCC should address groups of issues as soon as a decision can be reached, and not defer action until all issues can be resolved**

18. Waiting until all issues raised in Notice can be decided would delay important benefits to

broadband users. A better choice is to sequence what can be decided and resolve those issues first, while taking longer to resolve issues that require an additional record development. There are an enormous number of issues raised in this proceeding. They range from fairly straightforward issues, to those where there is substantial record development previously existing (and the decisional parameters are well understood by all stakeholders), to issues that require additional record development, including new NTIA analyses. Resolving some of the new and novel issues can be expected to take some time. But the simpler issues should not be held hostage to the most complex. IEEE 802 therefore recommends sequencing the decisions in groups, and releasing decisions as the FCC is positioned to make a final decision on groups of issues. A series of partial decisions allows benefits to flow immediately to consumers and business users, enabling improved broadband access for all. For example, as will be discussed below, incorporating 5825-5850 MHz into the U-NII rule framework is an example of “low-hanging fruit” that should be implemented immediately.

19. IEEE 802 suggests the following groupings, which could be resolved in “modular” way so that some modules could be decided and released at an earlier time:

- 1) Unifying U-NII -2C and U-NII-3, including resolution of the TDWR interference issues. There has been substantial discussion within the manufacturing community and with government stakeholders on this issue. A significant record exists on the TDWR issues, and based on the comments filed in this proceeding, the FCC should be well-positioned to reach a final determination. There are significant benefits if these issues can be resolved – a decision potentially eliminates a 50 MHz “notch” and provides certainty for TDWR operations.
- 2) “Low hanging” fruit from specific proposed 5 GHz changes. For example, the proposal to extend the U-NII 3 rules to the 25 MHz between 5825 and 5850 MHz should be adopted, as discussed below.
- 3) Remaining rule changes to 5 GHz bands that 802.11 devices currently share. The proposed changes to U-NII-1 band should be included.
- 4) Potential operations in the U-NII-4 band where there are some new and novel issues, but the candidate technology there (IEEE 802.11p) is part of same technology family as 802.11ac. Because this is a new sharing case, resolving it might take longer than items 1 or 2 above.
- 5) Potential operations in the U-NII 2B band where there are new and novel issues for sharing involving radio systems that 802.11 devices have not shared with before.

20. IEEE 802.11ac recommends that with this approach, the FCC could be positioned to start reaching

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decisions on some of these matters as soon as the first calendar quarter of 2014, if not before. More complex decisions will take longer. The balance of these comments discusses IEEE 802's view on these groups of issues.

#### **IV. The FCC should align U-NII-2 and U-NII-3 rules as proposed in the Notice**

##### **A. Apply a consistent set of rules across the U-NII-2 and U-NII-3 bands**

21. The Notice summarizes the status of various interference cases that the FCC investigated from 2009 to present, involving unlicensed devices causing interference to FAA Terminal Doppler Weather Radars (TDWRs).<sup>11</sup> The summary notes that the devices investigated were either non-compliant with FCC requirements or were devices that were compliant, but modified for unauthorized operation by users. In some cases, manufacturer design contributed to the ability of users to modify devices, a problem that the Notice explains has been addressed by revised certification requirements.<sup>12</sup> In addition to prior compliance issues, the Notice raises the issue of new devices, such as IEEE 802.11ac devices, that operate using wide bandwidths that extend across bands for which different rules exist. The FCC states that these two issues, and in particular the unauthorized re-tuning of U-NII-3 devices approved under Section 15.247 of the Commission's rules into the U-NII-2C band approved under Section 15.407 of the Commission's rules, merit a revised and consistent rules approach across U-NII-2C and U-NII-3. The FCC suggests that its rule be modified to apply Section 15.407 to all devices certified in those bands.<sup>13</sup> The FCC also proposes to require manufacturers implement security features so that third parties cannot reprogram the devices to operate outside the parameters for which the device was certified.<sup>14</sup> The Notice seeks comment on whether these two changes are sufficient to protect government radar systems, but then poses a series of questions about potential alternative solutions, such as geolocational databases,

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<sup>11</sup> Notice at ¶ 42-47.

<sup>12</sup> At present, the FCC requires equipment certified for the U-NII-2C band to notch the TDWR frequencies, include specific instructions to separate center frequency by at least 30 megahertz if a device is located within 35 kilometers of a TDWR, the applicant demonstrates there are no configuration controls accessible to the user and that there are no software configurations that allow users to select ad hoc networking, country codes or other modes that would disable dynamic frequency selection (DFS). See Notice at ¶ 45.

<sup>13</sup> Notice at ¶ 49.

<sup>14</sup> Notice at ¶ 51.

unwanted emissions limits, or sensing adjacent channels.<sup>15</sup>

22. IEEE 802 agrees with the proposal in the Notice that applying 15.407 certification requirements consistently across the U-NII-2 and U-NII-3 bands, improved security requirements, and the previously announced improvements in preventing user configuration of devices, fully address the enforcement cases seen to date and are sufficient to protect incumbent radar operations. While the 15.407 rules are more restrictive than the 15.247 rules, the history of the TDWR interference cases support the change proposed in the Notice. In fact, the FCC's proposals specifically address in a very targeted way the interference cases seen to date. As discussed below, IEEE 802 supports the FCC's proposals to apply improved security requirements to devices in these two bands, and to apply 15.407, including the proposals to apply the more restrictive unwanted emissions requirements and antenna gain requirements from 15.407 to both the U-NII-2 and U-NII-3 bands. IEEE 802 also presumes that the general test procedures in KDB 789033 for measuring the emissions compliance of U-NII devices to Section 15.407 requirements will continue to apply.
23. The sections below discuss the elements of each proposal and alternative proposal made in the Notice on these issues.

### **1. Improved security will guard against unauthorized use caused by user configuration**

24. To help guard against interference to incumbent radar systems in the U-NII-2C band, the Notice proposes that U-NII manufacturers implement security features for equipment that will operate "in the U-NII bands" to prevent third parties (such as users) from reprogramming the devices to operate outside of the rules for which the device was certified. The Notice states that U-NII devices are not required to be approved under Software Defined Radio (SDR) rules, which would require safeguards to prevent tampering with software. The Notice asks if the FCC should establish a requirement that manufacturers make it difficult for third parties to reprogram the embedded transmitter chip in certified devices, and further asks if it should require that an attempt to modify software or firmware by a third party should have the result that the device is rendered inoperable.<sup>16</sup>
25. IEEE 802 supports the FCC's proposal, and agrees that improved security measures could help guard against unauthorized use of devices. In asserting this new regulatory requirement, the FCC

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<sup>15</sup> Notice at ¶¶ 53, 54-56, 57-61, 62-65.

<sup>16</sup> The Notice does not propose that U-NII devices be certified as SDR, but that the devices are engineered to prevent users from tampering with the radio operations in a way that would lead to unauthorized and illegal use. Notice at ¶ 51.

should apply it to devices that are classified as “master” devices, which control the radio transmissions to and from their client devices (aka “slave” devices). Since master devices control the radio parameters used in 802.11 communications, the security requirement should logically apply only to the class of master devices that dictate radio emissions (e.g., channel choice, emission limits, etc.)

26. IEEE 802 notes that, in other certification contexts, the FCC has developed various methods for a manufacturer to demonstrate that its device is not subject to third party alteration. In its certification guidance KDB 442812, for example, the FCC provides several questions that applicants answer when making a security showing, and these same questions could help guide certification in this different context:

- Describe the procedure that ensures 3rd parties cannot operate US sold devices on non-US frequencies or in violation of any rule.
- Explain if any 3rd parties have the ability described above to change a device and operate it outside of US requirements.
- Describe how the software updates are distributed for all regulatory domains and what procedures ensure that a product sold in the US can only operate under US rules.
- If you assert that product can only be operated per US rules, explain how this is achieved.
- What stops third parties from loading non-US versions of software on to the device?
- Can third parties make factory level changes to reload non-US domain codes, etc.
- How would your code would defeat or mitigate against unauthorized changes to software?
- Provisions for labeling and general software description (block diagram)

27. These same types of showings, which have been utilized in other certification contexts, could be borrowed and used in this context to ensure that the U-NII device cannot be altered. Moreover, this proposal directly addresses a significant number of enforcement cases seen to date, in which users have unlawfully modified equipment to operate outside of bands for which the equipment was authorized. As the Notice states, that illegal post-manufacturer manipulation of the radios resulted in equipment that was operated at odds with radio emission requirements, and without DFS in bands that require DFS. Although the FCC has specifically stated that modifying radios to operate outside of their authorized bands is illegal<sup>17</sup>, that did not stop the activity that caused interference to TDWRs. IEEE 802 therefore concurs that industry can do more to guard against illegal user behavior.

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<sup>17</sup> KDB 594280.

28. The FCC should require an improved security showing, along the lines outlined above, for U-NII devices.<sup>18</sup> Had an improved security showing been in effect for master devices in the U-NII-3 band, it would have eliminated most interference cases, based on the record of cases resolved to date. Both the FCC and industry have some experience with similar improved security rules under the SDR certification regime, since SDR certifications have been available for years. These provisions appear to work well. There should be confidence on the part of stakeholders that requiring improved security to a broader class of master devices will yield the positive results the FCC seeks. IEEE 802 agrees that the benefits outweigh costs.<sup>19</sup>
29. The Notice also asks if it should require that manufacturers ensure that modifying or reconfiguring firmware or software will make a device interoperable in certain bands.<sup>20</sup>
30. IEEE 802 agrees that manufacturers should ensure that reconfiguring firmware or software which affects regulatory compliance, by someone other than the manufacturer or authorized by the manufacturer, is made very difficult.
31. The FCC also seeks comment on whether it should require U-NII devices to transmit identifying information so that, in the event interference to authorized users occurs, the FCC can identify the source of the interference and its location.<sup>21</sup> IEEE 802 is unaware of any technical capability that would allow 802.11 devices to transmit reliable identifying information for the purpose of identifying the cause of interference or its source. Nor has there been a requirement for “call signs” as there is no mechanism to record whose call sign is whose. SSIDs are usually broadcast by Masters, but do not have to be broadcast, and often don’t provide sufficient identifying information. Therefore, the only way to transmit locational information is to require a geolocation database and equipment that interacts with that database, as TV white spaces devices will do. The complexities associated with setting up a geolocational database in a band that has significant embedded base are quite high (as will be further discussed below). Implementing stronger protections for security as outlined above, along with applying 15.407 to U-NII-3, should be more than sufficient to prevent harmful interference to government radar systems. For this proposal, IEEE 802 believes the costs outweigh the benefits.

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<sup>18</sup> The FCC should not require U-NII devices to be certified as SDRs, an outcome that would raise other issues unrelated to the interference concerns at issue here.

<sup>19</sup> The FCC may consider providing further guidance offering additional specificity as to the detail of the security showing, or perhaps an illustrative example. That would help industry present a more uniform set of materials in support of its applications.

<sup>20</sup> Notice at ¶ 51.

<sup>21</sup> Notice at ¶ 51.



## 2. Certifying U-NII devices under the revised 15.407

32. The Notice proposes to revise certification rules for U-NII devices in a way that ensures the devices will be better harmonized.<sup>22</sup> IEEE 802 supports the proposed changes. It is important to craft rules that will ensure that devices operating using broad channelization do not increase the risk of interference to government systems. The revised approach also targets the issues that have been shown in the enforcement cases to be one of prime causes of interference to TDWR – very high gain antennas.
33. First, the proposal removes Section 15.247 certification as an option for devices that will be certified in the 5.725-5.85 GHz band.<sup>23</sup> Equipment would need to be certificated under Section 15.407. As the Notice states, this will ensure that all digitally-modulated equipment will operate using identical technical rules. IEEE 802 agrees and urges adoption of this change.
34. Second, the Notice also proposes to modify 15.407 to allow certification under that rule up to 5.85 GHz.<sup>24</sup> Previously, equipment authorized under 15.407 could only operate up to 5.825 GHz. As a result of the proposal, devices certified under the U-NII-3 band will now have full access, up to 5.85 GHz, to the band. IEEE 802 agrees and urges adoption of this change.
35. The Notice proposes to remove the Section 15.407 alternative variable power limit by removing the bandwidth dependent term ( $17 \text{ dBm} + 10 \log B$ ). As a result, the Section 15.407 power limit would be 1W.<sup>25</sup> IEEE 802 agrees, and also agrees with the Notice that this change does not contribute to interference environment because currently Section 15.247 allows certification of up to 1W.
36. The Notice also proposes to apply Section 15.247 Power Spectral Density (PSD) rules across U-NII-3.<sup>26</sup> As discussed in the Notice, relative to Section 15.407, Section 15.247 today allows a higher PSD when the device emission bandwidth is between 0.5 to 20 megahertz. As the Notice states, above a 20 megahertz emission bandwidth, the 1 Watt power limit becomes the limiting parameter, and the PSD is the same for equipment certificated under either Sections 15.247 and 15.407. The Notice, therefore, propose to modify Section 15.407 to match the PSD limit now used in Section 15.247 (i.e., 33 dBm/MHz), so that digitally modulated devices designed to meet this limit will continue to comply with the new PSD requirement under a revised Section 15.407. The Notice

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<sup>22</sup> Notice at ¶ 28-35.

<sup>23</sup> Notice at ¶ 28.

<sup>24</sup> Notice at ¶ 29.

<sup>25</sup> Notice at ¶ 30.

<sup>26</sup> Notice at ¶ 31.

states that this will ease the transition of all digitally modulated devices in the 5.725-5.85 GHz band to authorization and compliance under Section 15.407. As a result, the only change for digitally modulated devices will occur when the emission bandwidth is between 500 kilohertz and 20 megahertz. The Notice states that the rule revision would not increase the risk of potential interference because high-bandwidth devices like those typically used in U-NII applications will still be limited by 1 Watt total power.<sup>27</sup> IEEE 802 supports the proposed changes to Section 15.407's PSD rules and urge the adoption of the proposal.

37. The Notice also asks whether the FCC rules should increase the measurement bandwidth to 1 megahertz to reduce complexity and amount of time it takes to do measurement tests. Requiring devices that employ wider bandwidths to utilize a measurement bandwidth of 3 kHz may unnecessarily increase the time that it takes to complete measurement tests, according to the Notice. Moreover, changing the measurement bandwidth would promote consistency within the U-NII rules.<sup>28</sup> IEEE 802 agrees and proposes 33 dBm/1 MHz to reduce the measurement time.
38. To conform with the proposal to eliminate bandwidth-dependent limits on total power (above), the FCC also proposes to change the rule in Section 15.407 for emissions bandwidth, and replace it with the Section 15.247 requirement. This would change the minimum emissions bandwidth limit from 26-dB to 6-dB.<sup>29</sup> IEEE 802 agrees and urges adoption of this proposal.
39. The Notice also proposes to utilize the more stringent antenna gain from the existing Section 15.407 rule, instead of the Section 15.247 antenna gain that is allowable currently.<sup>30</sup> As the Notice states, the only difference between the two antenna gain rules is the maximum antenna gain that can be deployed without a penalty in transmitter power. Under Section 15.407, the rule assumes an antenna gain of 6 dBi, with 1 dB reduction in power required for every 1 dB that gain exceeds 6 dBi. Fixed point-to-point systems are required to reduce power by 1 dB for every 1dB that the gain exceeds 23 dBi. IEEE 802 agrees with this proposal, given that high gain antenna systems have been the source of many of the issues with TDWRs. While the reduction in antenna gain resulting from the adoption of Section 15.407 limits in the U-NII-3 band will reduce the range of point-to-point transmissions, the problems associated with these high gain systems have been highly disruptive to industry, resulting in a temporary suspension of certification approvals, and highly

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<sup>27</sup> The Notice notes that limiting the PSD to 8 dBm/kHz (33dBm/MHz) would result in a PSD that is higher than the total power limit of 1 watt (30dBm). Notice at ¶ 31.

<sup>28</sup> Notice at ¶ 31.

<sup>29</sup> Notice at ¶ 32.

<sup>30</sup> Notice at ¶ 33.

disruptive to government users and the FCC's own enforcement resources. Once equipment is certified and marketed under the new rule, the risk of interference to TDWRs (or other radars) should be reduced.

40. Moreover, the utilization of 15.407's antenna gain rule is not disruptive to the lion's share of 802 devices now used to deliver broadband access to consumers and businesses, as those devices do not utilize high gain antennas.
41. Similar to the antenna gain issue, the Notice also proposes to retain Section 15.407's approach to unwanted emissions requirements.<sup>31</sup> Section 15.407 requires unwanted emissions to be below -17 dBm/MHz within 10 MHz of the band edge, and below -27 dBm/MHz beyond 10 megahertz of the band edge.<sup>32</sup> Again, IEEE 802 supports this proposal and agrees that the Section 15.407 rule will better guard against unwanted emissions. In IEEE 802's view, this is another improvement in the rules that will help guard against harmful interference to TDWR.
42. Finally, the Notice proposes to utilize Section 15.407's 13 dB peak-to-average ratio across any 1 megahertz band. <sup>33</sup> Section 15.247 contains no such requirement. IEEE 802 agrees and urges support of this proposal.

### **3. Alternative proposals to address the TDWR issues are unnecessary and burdensome in light of the reforms to security, Section 15.407, and limits on user configuration**

43. As discussed above, the Notice proposes to impose improved security requirements on U-NII devices that will serve to block after-market user tampering with those devices in a way that alters emissions parameters. In addition, the Notice proposes to apply a revised Section 15.407, which has the effect of applying much more stringent requirements on U-NII-3. These two provisions, together with the previously-announced guidance that limits user configuration capability<sup>34</sup> have specifically targeted and addressed the issues that have arisen to date with U-NII devices interfering with TDWRs. The improved security rules that the Notice proposes will have the effect of preventing users from tampering with hardware and software to adjust radio emissions. The new Section 15.407 and specifically, its application to the U-NII-3 band, will ensure that the problems attributable to high gain point to point systems and their inability to coexist with radar will not

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<sup>31</sup> Notice at ¶ 34.

<sup>32</sup> See KDB 789033 D01- UNIII General Test Procedures v01r02.

<sup>33</sup> Notice at ¶ 35.

<sup>34</sup> [See KDB 594280 D01 Software Configuration Control v01r02]

occur. The FCC's announced rules to eliminate user configuration through user selection of geographic domains is another enormous improvement, as it will ensure that DFS cannot easily be disabled post-market by the selection of a domain that does not require DFS. As a result of these actions, which are fully supported by IEEE 802, the alternative ideas presented in the Notice to resolve these U-NII-2C issues become superfluous, unnecessary and burdensome. IEEE 802 does not support the adoption of a geo-locational database in this band at this time<sup>35</sup>, does not support either additional regulations that address unwanted emissions or frequency separation requirements.

44. In the Notice, geolocational databases are presented as an alternative or supplemental solution to the Notice's primary proposal to guard against interference to TDWR.<sup>36</sup> The Notice states that databases were discussed as a possible solution to the NTIA's desire to maintain both geographic and frequency separation from TDWR sites, in addition to an FCC requirement that manufacturers provide frequency and geographic separation guidance with their equipment. As part of that discussion, industry representatives indicated that high power point-to-point systems, operating under Section 15.247 of the rules, should be subject to a database requirement, as these systems appeared to be the ones causing interference.<sup>37</sup> The industry proposal assumed no changes to the Section 15.247 rule that are proposed in this docket, and was based on a view that the point-to-point systems at issue are virtually always installed by a professional installer who could manage the complexities associated with database registration. The view was further informed by the fact that none of the enforcement cases released to date shows an issue with 802.11-based equipment, which is often installed by consumers or non-IT staff members.
45. As stated above, IEEE 802 agrees with the primary proposal and believes that the proposed actions taken by the Commission – improved security and a more stringent set of emissions characteristics – together with actions already taken to reduce the ability of users to configure systems, are sufficient to address the issues raised by the TDWR examples. Unlike a “greenfield” band, the 5 GHz band has been in use to varying degrees for two decades. Imposing any database, much less a database that fully interacts with devices in the field, significantly alters equipment design, increases complexity, raises questions about database maintenance, and introduces significant uncertainty to an industry that today is delivering a wireless broadband access platform that by

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<sup>35</sup> IEEE 802.11 notes that the sharing issues associated with the 5350-5470 MHz band are difficult ones, the details of which NTIA is only now bringing to light. IEEE 802.11 reserves judgment on whether a database is a useful sharing mechanism for this band. IEEE 802.11 also takes no position in these comments on the ultimate solution for a sharing mechanism for 5850-5925 MHz.

<sup>36</sup> Notice at ¶ 54-61.

<sup>37</sup> Notice at ¶ 54.

some measures will account for over half of all IP traffic in the United States.<sup>38</sup> This is a far different proposition than when a device ecosystem is new, and there are no consumer expectations in terms of quality and price points yet built around it.

46. In addition, IEEE 802 can find no evidence of a Commerce Spectrum Management Advisory Committee (CSMAC) recommendation for a “Dynamic Database” for the 5 GHz band. Language akin to what the FCC cites in the Notice appears in drafts leading into the July 24, 2012 meeting but does not appear in the final recommendations of the Unlicensed Spectrum subcommittee.<sup>39</sup>
47. In addition to considering a geolocational database as a supplemental tool to protect TDWR, the Notice also raises a proposal to further restrict unwanted emissions by lowering emissions from U-NII devices at frequencies outside of the device’s operating bandwidth.<sup>40</sup> The Notice recites that the implicitly allowed maximum EIRP in the U-NII-2C band is 17 dBm/MHz, and that U-NII-2C devices can produce out of band emissions of no more than -27 dBm/MHz. The Notice states that NTIA has calculated that these limits “may not be sufficient” to protect TDWR from adjacent channel emissions from U-NII devices. The Notice suggests retaining the existing rule with respect to “indoor” devices while tightening the out of band emissions to no more than – 41dBm/MHz for “outdoor” devices. IEEE 802 disagrees with this approach, and notes that there has been no enforcement case brought to light that indicates there is an adjacent channel issue for U-NII devices. Moreover, the analysis relied upon in the Notice is an NTIA analysis that has not been borne out by how 802.11 equipment is used and operates in the real world. For example, the Notice states that some of the TDWR interference cases were caused by adjacent interference.<sup>41</sup> However, none of the enforcement cases released by the FCC to date shows evidence of adjacent channel interference. The equipment at issue in those cases was operating on channels that included the center frequency of the radar – therefore, the interference caused was co-channel and attributable to other causes (no DFS operating; operating outside lawful parameters; user tampering,

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<sup>38</sup> See Cisco Visual Networking Index (June 2012), estimating that after 2016, the majority of all IP traffic will originate or terminate on Wi-Fi. [www.cisco/go/vni](http://www.cisco/go/vni)

<sup>39</sup> The language as adopted allows for different approaches and does not specify a database: “in all new unlicensed bands, or in shared Federal bands designated for unlicensed access, that devices should be “connected devices,” which are required periodically to “call home” to: (1) Renew the authorization to operate in the band (2) Obtain a firmware update, to be remotely disabled in a particular frequency, and/or (3) Receive direction to move to another frequency band when necessary.” Proposed Recommendation #2, Unlicensed Subcommittee Final Report, CSMAC Meeting July 24, 2012 <http://www.ntia.doc.gov/meetings/CSMAC>

<sup>40</sup> Notice at ¶ 57-61.

<sup>41</sup> Notice at ¶ 42 (“there are some instances where the interference is caused by adjacent channel emissions”); Notice at ¶ 44 (“interference studies conducted by NTIA and FAA indicate that there may be some potential for interference from U-NII devices operating in frequencies...adjacent to radar systems).

etc.)<sup>42</sup> Given how critical IEEE 802.11 equipment is for deploying broadband, the FCC should not impose a new regulation unless there is clear evidence that the cost of the regulation does not outweigh the benefit. In this case, the benefits of new emissions limits are speculative, but the costs of restricting the equipment according to the proposed rule are very real and will result in significant degradation of the utility of equipment subject to the new out of band emissions limit.

48. In sum, the cases thus far present co-channel interference with TDWR, and are the result of user-generated issues, sometimes enabled by an overly flexible configuration capability that the FCC has since declared off limits. Moreover, we believe the FCC's decision to apply Section 15.407, as revised, to the U-NII-3 band is relevant, especially since the new rules would address the high gain system issues seen in some of the enforcement cases. In view of the other changes that the FCC is making to guard against TDWR interference the FCC should not impose new regulation unless there is clear evidence that the cost outweighs the benefit, especially given how critical 802.11 equipment is for deploying broadband.
49. The Notice also raises questions about another alternative or supplemental technique to protect TDWRs, to ensure that U-NII devices are transmitting at least 30 MHz removed from a nearby TDWR.<sup>43</sup> The text notes it is possible for the U-NII device to transmit on the same frequency as the radar when the radar signal falls within the 20 percent of occupied bandwidth that does not require sensing. The Notice asks if the FCC should require sensing over 100% of bandwidth. IEEE 802 disagrees that this should be required. Not only is there no real world example of this situation existing, sensing over 100% of bandwidth is burdensome. 802.11 devices operating pursuant to the rules they were certified under are not causing a problem, and should not be burdened with further regulation without real world examples of issues.<sup>44</sup>

## **V. The Commission should consider prompt adoption of rule changes that will improve the utility of the 5 GHz band for all users**

### **A. More clearly stated and improved DFS requirements should be adopted**

50. The Notice seeks to codify Office of Engineering and Technology certification guidance that has

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<sup>42</sup> IEEE 802.11 therefore disagrees with the finding in its January 2013 evaluation report to Congress, that adjacent channel interference is a concern. Notice at ¶ 110.

<sup>43</sup> Notice at ¶ 62-65.

<sup>44</sup> IEEE 802.11 is also supporting the proposed introduction of spectral density rules for devices approved under the relaxed sensing detection threshold of -62 dBm. See V.A., below.

been issued to clarify DFS requirements.<sup>45</sup> First, the Notice proposes that the FCC rules state that a manufacturer prevent the DFS mechanism from being disabled in devices certified to operate in U-NII-2A and U-NII-2C, and that U-NII devices operating in this band must do so with the DFS function “on”. Second, the Notice proposes that any U-NII device subject to DFS requirements that is capable of initiating a network must have DFS capability and be approved with that capability. IEEE 802 supports this codification of DFS requirements with respect to fixed access points and urges their prompt adoption. We agree that responsible operation of U-NII devices is a shared responsibility of manufacturers and users. In addition, and as discussed in Section VI, we recommend adding the option for a low power mode on DFS channels, meaning, devices that do not support DFS, will be able to operate on DFS channels, with a power limitation.

51. Next, the Notice introduces a spectral density requirement for those devices seeking to certify under the relaxed sensing detection threshold of -62 dBm used for co-channel sensing. The Notice proposes, for -62 dBm category of devices, an EIRP of less than 200 mW (23 dBm) and an EIRP spectral density of less than 10 dBm/MHz (10 mW/MHz). The Notice states this is consistent with recent changes in ETSI standards used in Europe which industry complies with today. Devices that do not meet the proposed EIRP and EIRP spectral density requirements must use the -64 dBm sensing threshold. IEEE 802 supports this proposed change for this class of devices, and agrees that it will further enhance protections for radar from co-channel interference.

52. Next, IEEE 802 supports adoption of the negotiated and revised Bin 1 test for DFS.<sup>46</sup> The revised test now includes test patterns that reflect actual TDWR operation. IEEE 802 is concerned that the original Bin 1 did not reflect the operational characteristics of the FAA weather radar systems. While we can find no enforcement case illustrating that properly functioning DFS failed to detect TDWR, IEEE 802 appreciates that this critical test, which all U-NII devices must pass to operate in U-NII-2A and U-NII-2C, must reflect the operational parameters of government systems. The revised Bin 1 does so, and the new test will address concerns about future interference to TDWR. IEEE 802 also agrees with the Notice that future adjustments to measurement procedures should not require a rulemaking, and could be updated by the Office of Engineering and Technology on delegated authority.

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<sup>45</sup> Notice at ¶ 68-70.

<sup>46</sup> Notice at ¶ 73.

53. The Notice also asks if the FCC should eliminate the uniform channel spreading rule.<sup>47</sup> IEEE 802 agrees. The original purpose of rule was to prevent large number of devices from starting up on one channel. Since that time, and with the introduction of 40, 80, and eventually 160 MHz channels, the rule no longer serves a meaningful purpose. IEEE 802 further agrees that either random channel selection or manual selection of channels on start up should be allowed.
54. IEEE 802 also supports the FCC proposal to revise the channel loading measurement approach now used with DFS testing – namely, the MPEG test file.<sup>48</sup> This test has been outmoded by the development of 802 technologies. IEEE 802 recommends that the current channel loading file approach be replaced with a test which consist of packet transmissions that together exceed the transmitter minimum activity ratio of 30% measured over an interval of 100 ms. The required traffic loading can be generated either via audio or video streaming, data file transfer, or using network testing tools that can generate data streams (e.g., iperf, Chariot, etc.). We note that this change would make the testing method consistent with recent European Telecommunications Standards Institute (ETSI) rules (EN 301 893).
55. Furthermore, IEEE 802.11 working group is asking to clarify that FCC allows in the rules the following behavior by a Master device: A Master is allowed to perform the channel availability check on multiple channels during device power up per existing Part 15 test methods to ensure that no radar is operating. In this way a list of “available channels” may be formed and retained by the Master as long as it is powered up. The Master would be allowed to immediately commence operation on any available channel during operation and immediately commence in-service-monitoring . No new CAC would be required immediately before commencing operation on an available channel or switching to another channel in the list of “available channels”. All other existing channel closing and non-occupancy rules remain in force. In summary, the Master can operate in one or more of the “available channels” and change its operating channel, without repeating a new CAC before commencing operation on another available channel. This behavior is recognized in DFS conformance rules in other regions.

**A. The FCC should adopt the “miscellaneous” rule changes proposed**

56. IEEE 802 supports the following miscellaneous rule changes detailed in the Notice, and urges their

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<sup>47</sup> Notice at ¶ 74.

<sup>48</sup> Notice at ¶ 74.



prompt adoption<sup>49</sup>:

- Section 15.403 definitions replaces “Peak Power Spectral Density” with “Maximum Power Spectrum Density. IEE 802 also suggests a modification to Section 15.403(s) to include the 5.825-5.850 MHz spectrum in the definition of U-NII spectrum to help ensure that spectrum will be used by broadband technologies.<sup>50</sup>
- Section 15.407 – deletes the second sentence which is no longer relevant; also replaces “peak” with “maximum”; and specifies that all peak excursion measurements are to the highest average in each corresponding 1 megahertz band.
- Section 15.215 – clarify that the 20 dB bandwidth limitation for ultrawideband devices does not apply to 15.407 devices so as to allow wide channelization of U-NII devices.
- Section 15.247 –correcting the section numbers in paragraph (b).

In addition, in order to provide some further simplification of the rules, IEEE 802 proposes that the Commission change the PSD requirements from 8 dBm/3 kHz to 23.2 dBm/100 kHz for the sub-1GHz unlicensed bands to harmonize the PSD measurements with Part 15 Subpart H rules.

## **B. Adopt the proposed transition period for equipment to comply with newly-enacted rules**

57. The Notice proposes a 12-month period for manufacturers to produce compliant equipment after adoption of a rule change and a two year period from the date of rule change to actual cessation of permissive changes to formerly compliant equipment. Essentially, the cessation of permissive changes functions as a “stop” date, as manufacturers can no longer evolve the formerly compliant equipment to keep up with new technology and capabilities. The Notice proposes to grandfather existing equipment and not require that the existing equipment be replaced.<sup>51</sup> IEEE 802 agrees with the proposed transition rule, and notes that it closely approximates industry’s actual experience in other rules transitions. However, IEEE 802 notes that the FCC should allow an exception to the two year stop date for permissive changes in one case – when the permissive change is being filed to upgrade the existing device to the new Bin 1. This upgrade will help ensure that the embedded

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<sup>49</sup> Notice at ¶ 113.

<sup>50</sup> This rule change and proposed change following align with ANSI C 63.10 Rev 2.

<sup>51</sup> Notice at ¶ 114-115.

base of equipment is equipped with the latest technology for the detection of government radars, and only improves the operation of the band.

**C. FCC should immediately add 5825-5850 MHz to Sections 15.407 and make conforming edits to Section 15.403(s)**

58. IEEE 802 supports the inclusion of 25 MHz, from 5825-5850 MHz, to the U-NII-3 band and to the U-NII rules.<sup>52</sup> As the Notice repeatedly states, crafting a more consistent set of rules across the 5 GHz band can be helpful to advance U-NII use of the band, and also better help support the sharing environment for all users. Conforming Section 15.403(s) to the proposed change also ensures that only U-NII devices will be certified for the band and greatly mitigates the sharing concerns.

**VI. Some of the proposed rule changes are likely to require additional consideration based on the record**

**A. DFS and the evolution of master devices**

59. As discussed in the Notice, the success of IEEE 802 devices and their widespread adoption by consumers and businesses is causing rapid technological innovation.<sup>53</sup> Whereas a few years ago, IEEE 802.11 could be characterized as a fixed/wired access point operating as a “master” device communicating wirelessly to a “client” device, today we see wireless devices operating as “master” devices, or radios that distribute the sensing function among various “client” devices. The Notice asks for comment on its proposed rule that certified U-NII devices operating in the U-NII-2A and U-NII-2C bands capable of initiating a network must have radar detection functionality and must be approved with that capability. As stated in Section V, above, we support the proposal with respect to fixed/wired access points and urge its prompt adoption. In addition, we recommend adding the option for a low power mode on DFS channels, meaning, devices that do not support DFS, will be able to operate on DFS channels, with power limitation.

60. The Notice also inquires whether the existing DFS rules for U-NII-2A and U-NII-2C will limit the

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<sup>52</sup> Notice at ¶ 29.

<sup>53</sup> Notice at ¶ 69.

type of applications that have been or could be implemented in the bands.<sup>54</sup> IEEE 802 believes that the DFS rules are limiting new applications.

61. Historically, an access point establishes an infrastructure Basic Service Set (BSS) in U-NII-2A and U-NII-2C by assuming the role of DFS master. As part of the process to establish the BSS, the access point performs the 60 second channel availability check (CAC) to detect whether there is radar activity on the channel. Then during BSS operation, the access point periodically scans for radar to ensure compliance with in-service monitoring regulations. With new Wi-Fi Direct mobile applications, the Group Owner (GO) is required to act as the DFS master in the U-NII-2A and U-NII-2C bands. These new Wi-Fi Direct applications are typically short range connections between two nearby devices. The 60 second CAC and in-service monitoring regulations have limited the use of these bands by these short-range mobile devices. The use cases provided in APPENDIX 1 describe two such restrictions. For that reason, IEEE 802 is recommending a low power mode exemption to DFS.

## **B. U-NII-1 proposed revisions**

62. The Notice raises a series of questions about the current rules for the U-NII-1 band, which is limited both by power and an “indoor operations only” requirement.<sup>55</sup> Today, the rules specify a peak transmitter output power of 50 mW with up to a 6 dBi antenna gain permitted (equivalent to 200 mW EIRP), and a transmitter peak power spectral density of 2.5 mW/MHz (or 4 dBm/MHz) for the same 6 dBi antenna gain. Cochannel use of the band in the United States is for NGSO/Mobile Satellite feeder links, currently licensed to Globalstar. The Notice states that “the wireless device market has changed dramatically” since these rules were adopted in 1997, and that the ubiquitous and robust use of unlicensed devices often require more power than what the U-NII-1 band delivers. The Notice therefore proposes to harmonize the U-NII-1 power rules with U-NII-2A, in addition to harmonizing the power spectral density rules and allowing outdoor operation.
63. IEEE 802 agrees. As the Notice states “ [h]armonizing the power and use conditions across the lower 200 megahertz of U-NII spectrum would likely permit the introduction of a wide-range of new broadband products capable of operating at higher data rates than is now possible.”<sup>56</sup> The broadly channelized 802.11ac technology deploying this year cannot today make full use of this

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<sup>54</sup> Notice at ¶ 70, 80.

<sup>55</sup> Notice at ¶ 36-41.

<sup>56</sup> Notice at ¶ 39.

spectrum, given the regulatory limitations on it. For example, those seeking to deploy at 250 mW (the U-NII-2A limit) for all or part of the U-NII-1 band cannot do so. Service providers and other users of the technology therefore would benefit if the U-NII-1 rules can be revised to align with U-NII-2A.

64. IEEE 802 also notes that the current rule, constraining the band to “indoor” use, is today limiting applications that can be delivered to the marketplace. As discussed above, historically, an infrastructure base station signal is established on a channel in the UNII-1 band with an indoor access point (AP). However, the indoor restriction blocks new consumer applications where a Wi-Fi Direct device associates to a Wi-Fi Client device. Today, because the Wi-Fi Direct device may be outdoors, the use of the band is restricted. Examples of specific cases are provided in APPENDIX 2 to this pleading and include diagrams of the issues confronting Wi-Fi Direct devices in the U-NII-1 band. Therefore, the IEEE 802.11 Working Group recommends removing the indoor requirement to enable all peer-to-peer use cases that are currently blocked even when all peers are indoor.

## **VII. U-NII-4 Band rules should be considered before U-NII-2B rules**

65. As discussed above, the Notice recognizes, and we agree, that one of the motivating goals for this proceeding is the search for contiguous spectrum to support the next generation of 802.11 products. These products use wide channels of 80 or 160 megahertz to deliver multi-gigabit throughput speeds, among many other technical innovations. With a contiguous footprint, there will be nine 80 MHz channels or four 160 MHz channels. Without access to contiguous spectrum, the number drops to five and one, respectively. Future increases in traffic demand would therefore need to be accommodated on fewer channels. For that reason, the Notice asks a series of questions about whether U-NII-4 could be shared with U-NII devices. Sharing in both the U-NII-3 and U-NII-4 bands would add one 80 MHz and one 160 MHz channel.
66. Incumbents in the U-NII-4 band exist, both federal and non-federal. The Notice provides a summary of the federal allocations, and specifically calls out radar operations.<sup>57</sup> Non-federal systems included in the band are earth station uplink services for international intercontinental satellite systems and an allocation for Intelligent Transportation Service (ITS) for Dedicated Short

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<sup>57</sup> Notice at ¶ 88-89.

Range Communications Service (DSRC).<sup>58</sup>

67. IEEE 802 notes that with respect to federal radar systems in the band, the technology in use for managing unlicensed devices in the presence of radars is DFS. We recommend that the going-in hypothesis is that the existing or modified DFS could work to ensure that these federal radar systems do not experience harmful interference.<sup>59</sup> We note that the NTIA will be performing studies, and is in a good position to recommend whether existing DFS can work or will need to be modified, as industry does not have access to much information about radar emissions parameters beyond the basic information contained in the NTIA report, indicating that the radars may have emissions that include sub-microsecond pulsewidths. More information will need to be gleaned from NTIA's examination of this issue to determine next steps.<sup>60</sup> In response to the Notice's question about pulsewidth detection capability, ETSI requires detection of 0.5 microsecond pulsewidths, which represents industry's present capability. The issue is not, of course, detection of one pulsewidth, but detection of the radar bursts over a test pattern to a measured probability of detection.
68. IEEE 802 does not agree that imposing adjacent channel sensing is necessary for the protection of radar in the band.<sup>61</sup> As stated above, we believe the case for adjacent channel sensing is speculative, not borne out by real world examples, and is very costly in terms of degrading the operation of commercial Wi-Fi equipment that would operate in the band.
69. In the view of IEEE 802, DSRC protection is the new problem to be resolved in this proceeding. As the transportation industry has evolved its vision of ITS, the underlying DSRC technology has been evolving. The candidate technology to become DSRC is now 802.11p, a technology that is part of the 802.11 family and borrows some of its capabilities. From our membership, we are aware that there are many companies whose engineers were represented in 802.11p standards and continue to be involved in the other 802.11 working groups, which means much of the industry is actively supporting both commercial 802.11 as well as DSRC technologies. We strongly prefer a set of FCC rules that will allow both sets of technologies to flourish. As the Notice states, DSRC is itself an evolving technology designed to improve safety in situations involving vehicles. The Notice lists the vehicle to vehicle communications that will warn of a dangerous condition or event, as well as vehicle-to-infrastructure communications. These implementations need secure, dependable wireless

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<sup>58</sup> Notice at ¶ 90-93. The Notice also notes that Amateur Services may use the U-NII-4 band. Notice at ¶ 94.

<sup>59</sup> Notice at ¶ 98.

<sup>60</sup> IEEE 802.11 does not mean to minimize the coexistence issues with satellite uplinks, but does note that these are geographically isolated.

<sup>61</sup> Notice at ¶ 98.

communications with low latency to perform their intended function. 802 notes that the onboard transmitters for DSRC are licensed by rule, and are therefore primary. Infrastructure transmissions are licensed by the FCC – again, these have primary status in the band. As IEEE 802 views the question posed by this proceeding, the issue is whether there will be spectrum, which at any given location at any given time, is not in use by DSRC and which could be used by U-NII devices if those devices cause no harmful interference to DSRC operations.

70. Based on past experience in advising the FCC on sharing technologies, IEEE 802 is not of the view that the cycle of written comments and reply comments will resolve whether a sharing case exists, much less whether it can be proved out to the satisfaction of stakeholders.<sup>62</sup> Sharing is technically complex, and those designing sharing technologies need to deeply understand what is being asked of the technology. Although DSRC has some of the 802.11 characteristics, DSRC was not designed at a standards level to share with commercial 802.11 products.
71. Nevertheless, there is some reason to think that a sharing concept can be created and tested. As stated, the 802 community would like both technologies to succeed, and has interest in offering solutions for the implementation of DSRC in the automotive market. Because the two technologies are part of a common standards family, and DSRC technology is based on an amendment to the base IEEE 802.11 specification, both commercial 802.11 and DSRC have a common base. Since both are IEEE 802.11 based technologies, we believe that there is a way forward to address the concerns of the ITS community about potential interference to their system from commercial 802.11 devices.
72. We recommend that stakeholders from both sides hold a series of meetings to (1) Exchange information on respective requirements, (2) Discuss possible mitigation solutions prepared by the technical experts from the 802.11 community, and (3) Come to an agreement on a mutually acceptable solution for testing/implementation. The follow-on step may involve development and testing of prototypes in the DRSC test bed to ensure the solution works not just in the lab, but in real life, and that it is acceptable for full implementation. If brought to fruition, then industry participants would need to work closely with FCC and other government agencies to develop certification rules that unlicensed devices will use to gain FCC approval, including potentially additional tests to ensure the certification rules operate as intended. 802 recognizes its role in standardizing aspects of the solution, as appropriate, and encourages participation from stakeholders in the ITS community." It is important to emphasize that all key stakeholders are

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<sup>62</sup> Notice at ¶ 101.

represented in this FCC process. We encourage that the above outlined process be initiated at the earliest possible time.

73. Finally, the Notice proposes to apply the revised Section 15.407 to the U-NII-4 band for U-NII devices.<sup>63</sup> If adopted, and if the 5825-5850 MHz band is added to U-NII-3 as previously discussed, devices could operate according to common technical parameters across 200 megahertz of spectrum, either indoors or outdoors. While 802 recognizes the benefits for unlicensed devices if the revised Section 15.407 is applied to the U-NII-4 band, it also recognizes that those rules create a potential for harmful interference with DSRC devices operating at typical (10 dBm to 20 dBm) transmit power. The technical parameters for operation in U-NII-4 represent a part of the sharing solution that must be developed.

## **VIII. U-NII-2B rules will require novel approaches to protect incumbent systems**

74. As discussed above, the benefits to U-NII technology of achieving a contiguous band of spectrum are tremendous. Therefore, the examination of the U-NII-2B band must be undertaken, even though the challenges identified in the NTIA report raise new and novel sharing issues.<sup>64</sup> From that report, we know that there are incumbent users consisting of ground-based, air, and ship-borne radar from a variety of agencies (DoD, Coast Guard, NASA, NOAA, DoE). There are Spaceborne Altimeter Radar Systems as well as US government use of Canadian Earth Exploration Satellite Systems. There is telemetry for unmanned airborne vehicles by several agencies, and non-federal users as well.<sup>65</sup> IEEE 802 agrees with the NTIA report that additional study is needed<sup>66</sup> and agrees with NTIA characterization of mitigation techniques known today.<sup>67</sup> More information will need to be known in order for the commercial industry to put forward potential sharing ideas. We look forward to reviewing the NTIA report on this issue.
75. For the time being, IEEE 802 agrees with the Notice that if the band can be opened for sharing, then logically the technical rules should adopt Section 15.407.<sup>68</sup> This will ensure that all of the U-NII-2 bands operate under a common technical framework, and will facilitate the use of devices that have

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<sup>63</sup> Notice at ¶ 97. The Notice specifically refers to Section 15.407(b)(4) of the Commission's Rules, 47 C.F.R. § 15.407(b)(4).

<sup>64</sup> Evaluation of the 5350-5470 MHz and 5850-5925 MHz Bands Pursuant to Section 6406(b) of the Middle Class Tax Relief and Job Creation Act of 2012, US Department of Commerce, January 2013.

<sup>65</sup> Notice at ¶ 83-87.

<sup>66</sup> Notice at ¶ 103.

<sup>67</sup> Notice at ¶ 106-108.

<sup>68</sup> Notice at ¶ 98.

broad channelization. IEEE 802 opposes, however, the imposition of a new out-of-channel emissions limit for outdoor equipment of -41dBm/MHz.<sup>69</sup> Such a restrictive rule would adversely affect the utility of 802.11 outdoor operations, and should not be imposed at this time, and particularly in advance of specific proposals about how IEEE 802.11 commercial Wi-Fi could successfully share with IEEE 802.11p.

## **IX. Conclusion**

76. IEEE 802 commends the FCC for crafting a wide-ranging notice that will create a set of operating rules and requirements to support next generation 802.11 technology. The number of issues raised in this proceeding is large, and the difficulty of a few of the issues, is not to be underestimated. However, the potential benefits to providing next generation IEEE 802.11 technology are important. We look forward to working with the Commission and all stakeholders on these questions.

Respectfully submitted,

/s/ Paul Nikolich

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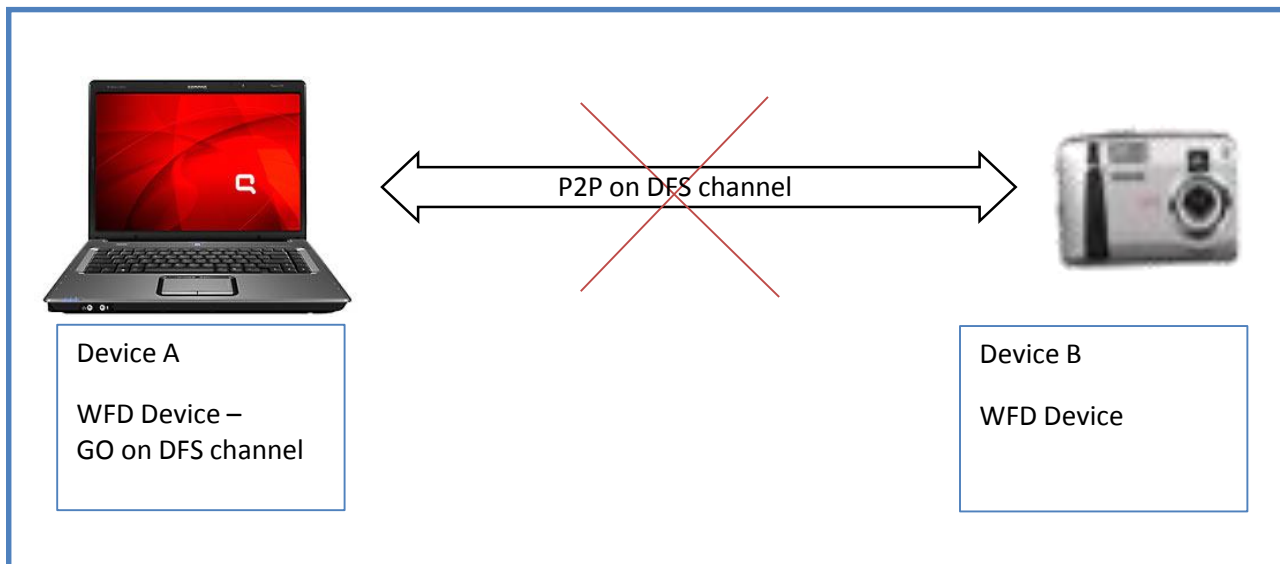
<sup>69</sup> Notice at ¶ 96.



## APPENDIX 1

**REFERENCING ¶70 AND ¶80, BELOW ARE EXAMPLE USE CASES WHICH WOULD BE ENABLED BY CREATING A CLASS OF DEVICES WHERE DFS WILL NOT BE REQUIRED IN UNII-2A AND UNII-2C BANDS.**

### **Case 1: Temporary, short-term WFD connections**



1. DFS bands are not conducive to temporary, short-term WFD connections.
2. For example, a quick file transfer of photos between a laptop and camera would have to wait for the 60 sec initial radar scan, significantly increasing transfer time.

### **Case 2: Interruption of service during WFD connection**

3. When an active WFD connection is in place, e.g. file transfer, radar detection might trigger in the WFD group owner (DFS master device) either due to false detect or due to an actual radar. In this case, GO needs to switch to another channel, which might be a DFS channel because of the uniform spreading rule, and do a new channel availability check. The channel availability check interrupts the WFD service for at least 60 seconds.

### **Case 3: Simultaneous connection to AP and WFD peer**

#### **Use Case:**

- AP established BSS in the 2.4GHz band
- Device A
  - associated with AP for LAN/internet connectivity
  - capable of WFD GO
  - DFS Master Capability
- Device B:
  - WFD Device with DFS Client capability
- Device A wishes to establish a direct peer-to-peer link with Device B for file transfer

#### **Assumptions:**

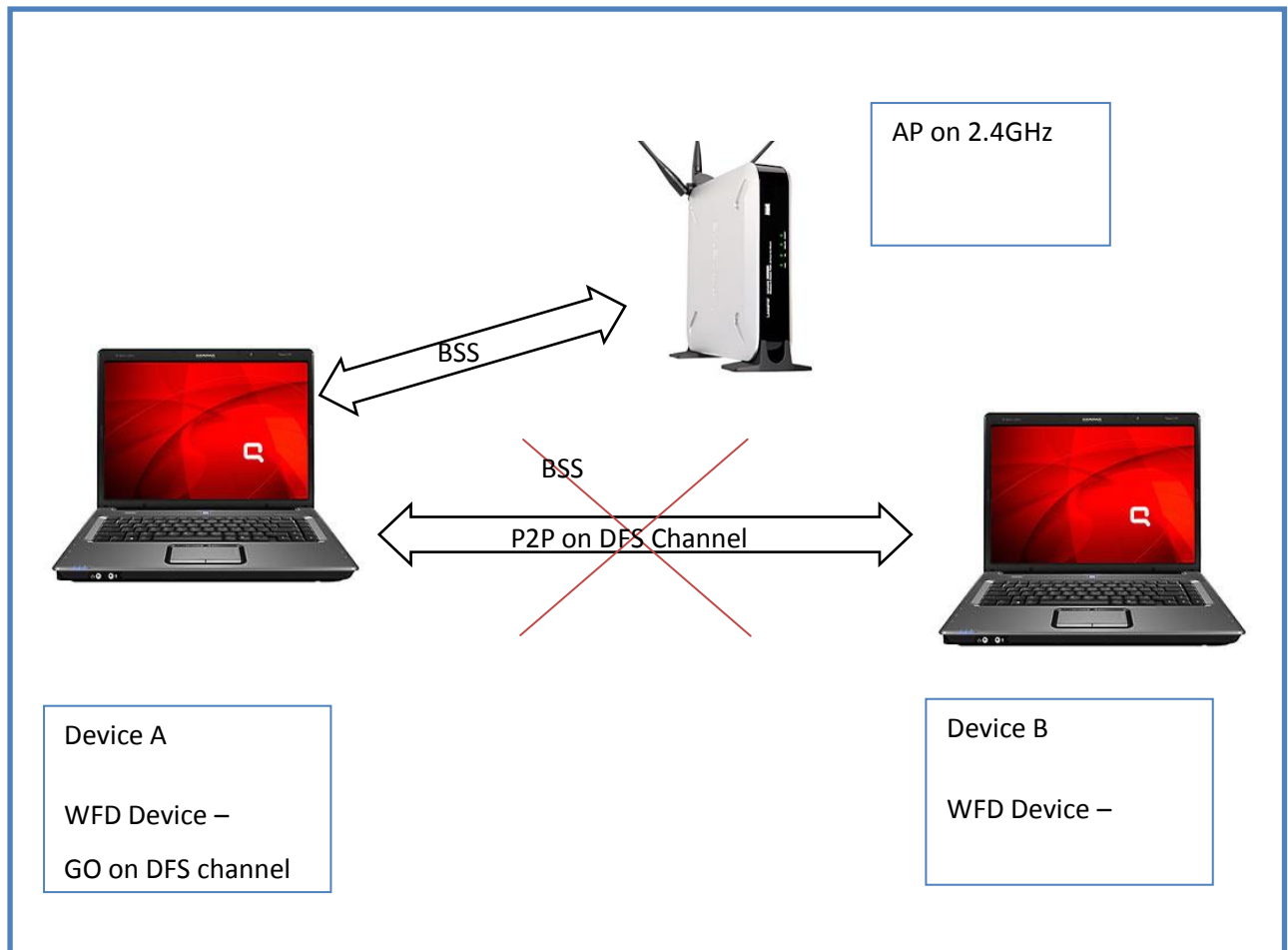
- a. Device A supports DFS master capability and can operate as a GO on DFS channel

#### **Cost effective implementation:**

4. The most cost effective way for a mobile device to support a simultaneous connection to an AP and WFD peer is with multi-virtual MACs (support virtually several MACs with only one HW) and to time multiplex RF/baseband hardware between different channels. However “different channel” support is problematic, as a WFD GO on a DFS channel must stay on the channel to perform in-service monitoring. If the GO leaves the channel (power save, other channel activity, scanning for WiFi discovery, etc), when returning to the channel the GO is required to re-do CAC and scan the channel for radar activity for 60 sec.
5. Therefore performing CAC before any transition to the DFS band, while a GO is connected with WFD Clients, and also has an active BSS connection to the AP on a different channel, will have several negative effects:
  - a) The GO is not allowed to transmit anything (including beacons) until the CAC is over, therefore, all WFD clients that are connected to the GO will probably get disconnected since they would not have received a beacon for at least 60sec.
  - b) The connection to the AP on the other channel (other MAC) will probably get disconnected as well since the device disappeared for at least 60 sec.
6. This means that devices that support DFS as such are not really capable of supporting multiple virtual Macs on different channels on DFS channels.

#### **Resulting use case restrictions:**

7. To avoid congestion and interference in the 2.4 GHz band, Device A desires to establish a GO on a DFS channel to perform the file transfer. However according to the description above, if it does so, both connections will be lost.
8. The restrictions on DFS channels blocks valid low range usages since, even where Device A supports DFS as a GO, it is not effective to operate as such due to the disconnection implications, and they must communicate on other non-DFS bands.
9. An alternate implement to time multiplex RF/baseband hardware is to implement dual-band/channel simultaneous support. This adds substantial hardware cost and battery consumption to mobile devices and severely limits commercial acceptability.



## APPENDIX 2

**REFERENCE ¶39, BELOW ARE EXAMPLE USE CASES WHICH WOULD BE ENABLED BY ELIMINATING OUTDOOR REQUIREMENT IN UNII-1 BAND.**

**Case 1: Legacy client (without WFD capability) may not connect to a WFD GO on UNII-1 band**

**Use Case:**

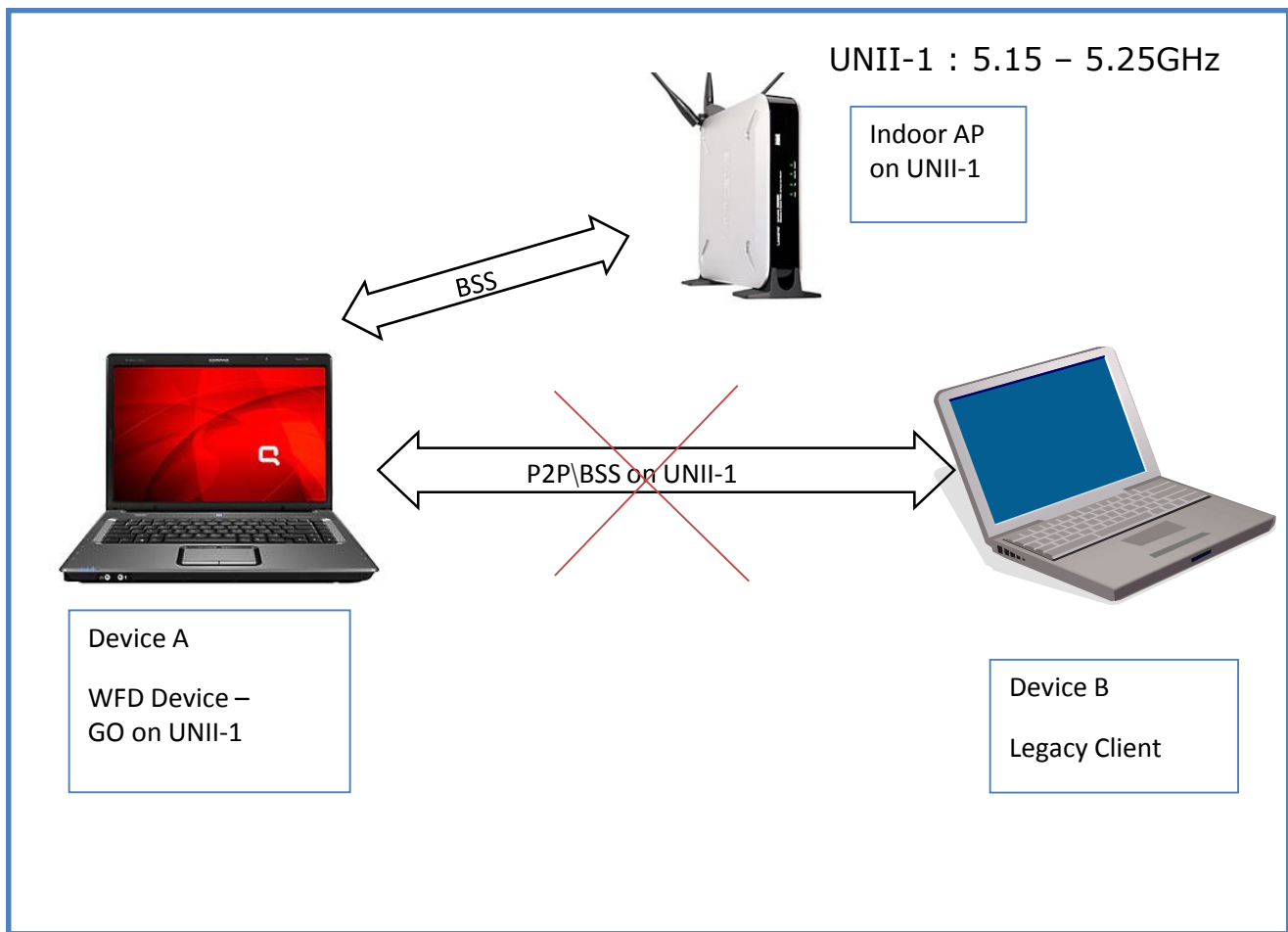
- Indoor AP established BSS on UNII-1
- Device A
  - associated with AP
  - capable of WFD
- Device B:
  - not associated with AP
  - legacy device not capable of WFD
- Device A wishes to establish a direct peer-to-peer link with Device B for file transfer

**Assumptions:**

- a. Device A is allowed to establish a P2P BSS on UNII-1 if it is connected to an AP on UNII-1 band, ensuring it is indoors.
- b. Device A, operating as a WFD GO, will appear to Device B (legacy client) as an indoor fixed AP.
- c. Device A does not know whether Device B is indoors or outdoors.

**Resulting use case restrictions:**

1. Since Device B may be twice as far from the AP as Device A, the probability of it being outdoors is increased. As such, Device A must refuse a connection attempt from Device B to ensure that outdoor devices are not allowed to operate on the indoor band.
2. The restriction on outdoor operation blocks valid indoor usages since, even where both Device A and Device B are indoors, Device A must refuse a connection attempt from Device B.



**Case 2: P2P Device that is Battery powered and doesn't support concurrent connection (or doesn't support BSS connection at all)**

**Use Case:**

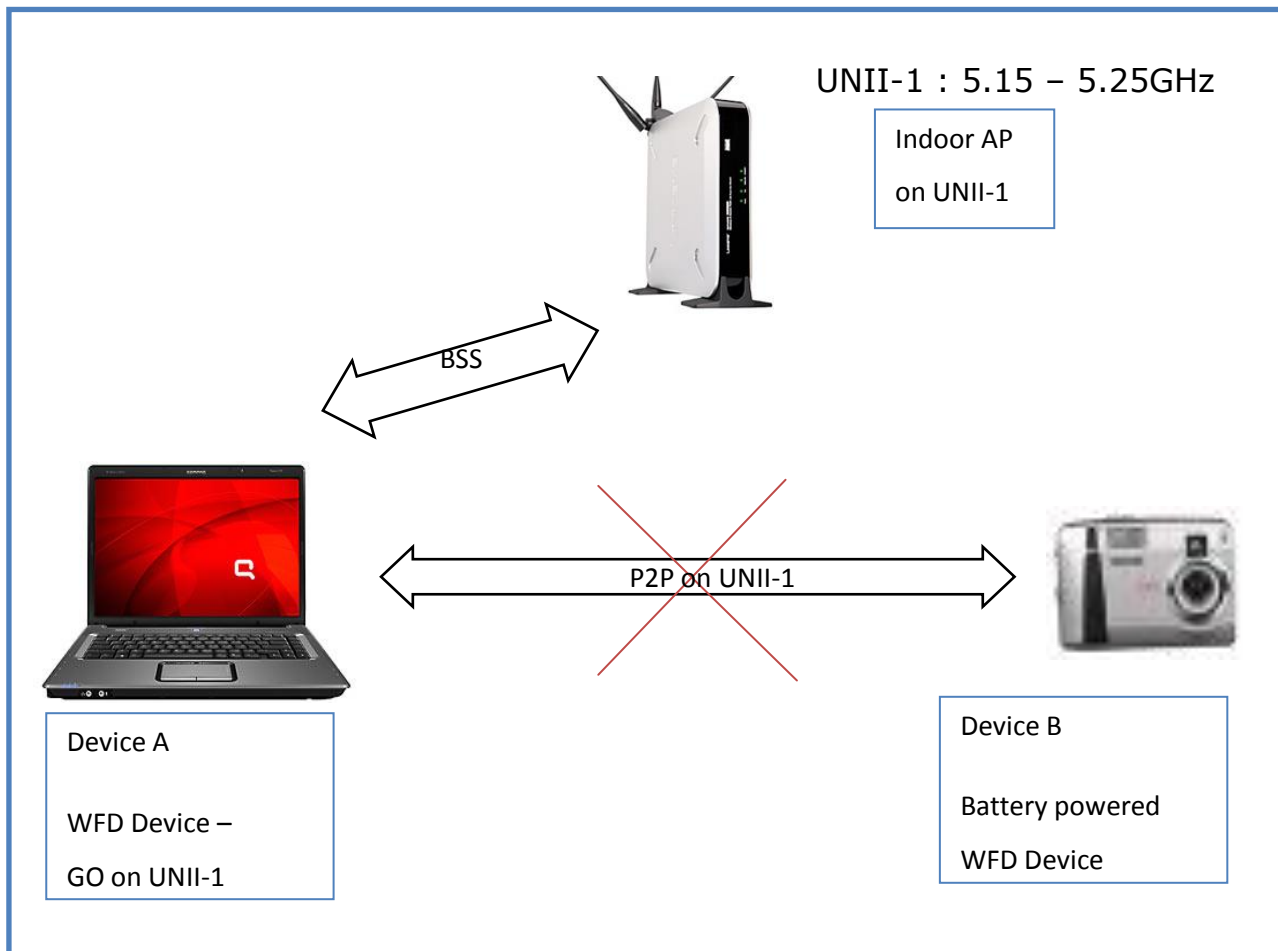
- Indoor AP established BSS on UNII-1
- Device A
  - associated with AP
  - capable of WFD
- Device B:
  - not associated with AP
  - Capable of WFD and not connected to the AP
- Device B wishes to establish a direct peer-to-peer link with Device A for file transfer

**Assumptions:**

- a. Device A is allowed to establish a P2P BSS on UNII-1 if it is connected to an AP on UNII-1 band, ensuring it is indoors.
- b. Device A, operating as a WFD GO, will appear to Device B as a P2P GO
- c. Device A does not know whether Device B is indoors or outdoors.
- d. Device B cannot be the GO on indoor band since it's not AC powered and not connected to indoor AP

**Resulting use case restrictions:**

3. Since Device B may be twice as far from the AP as Device A, the probability of it being outdoors is increased. As such, Device A must refuse a connection attempt from Device B to ensure that outdoor devices are not allowed to operate on the indoor band.
4. The restriction on outdoor operation blocks valid indoor usages since, even where both Device A and Device B are indoors, Device A must refuse a connection attempt from Device B.
5. For example: a camera that supports only P2P connection to a computer for downloading pictures.



**Case 3: We cannot establish a GO on UNII-1 band if our BSS connection is on a different band, even though we are indoors**

**Use Case:**

- Indoor AP established BSS on the low band 2.4GHz or any non-UNII-1 band
- Device A
  - associated with AP
  - capable of WFD
- Device B:
  - WFD Device not connected to UNII-1 band AP
- Device B wishes to establish a direct peer-to-peer link with Device A for file transfer

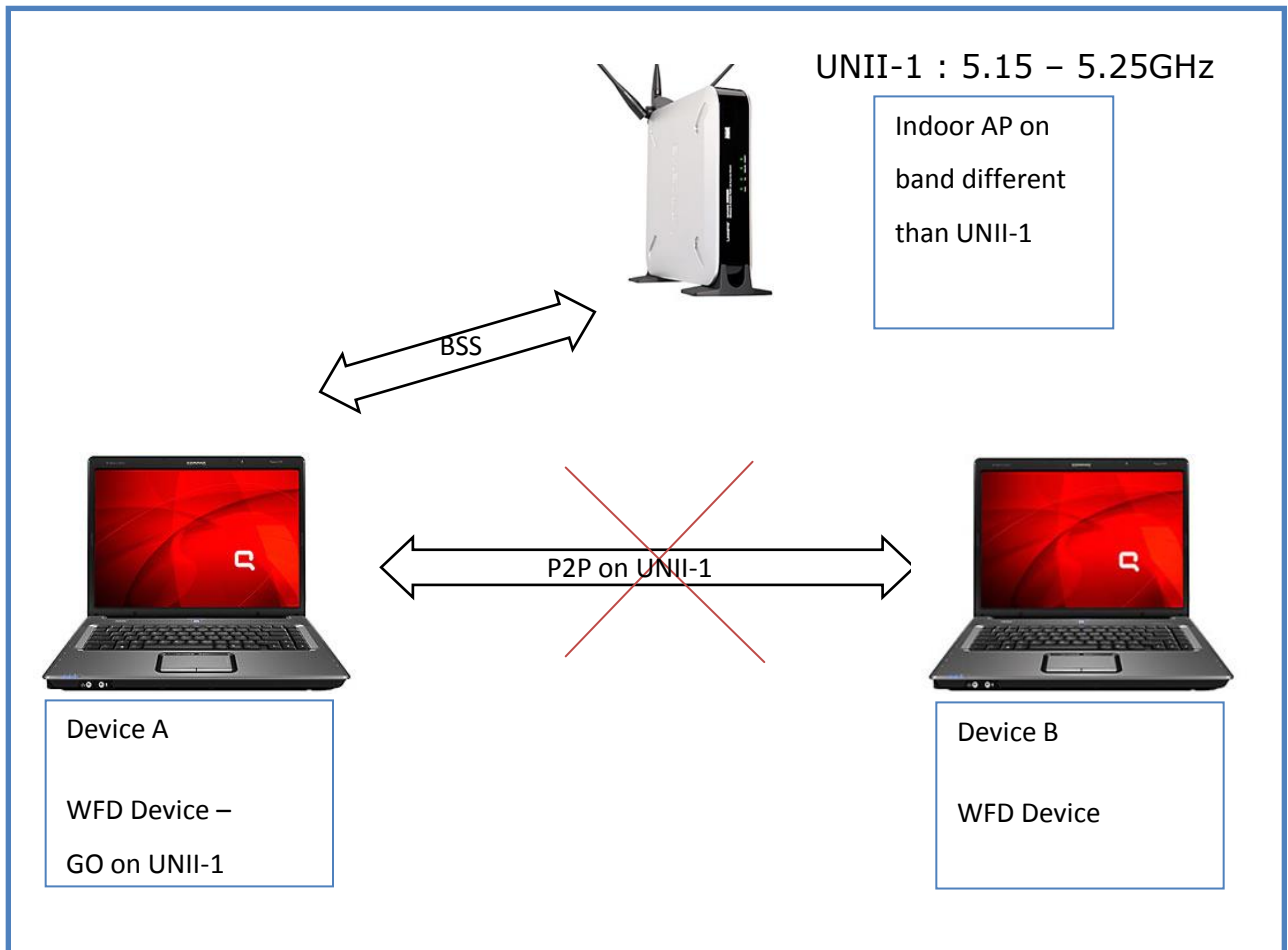
**Assumptions:**

- a. Device A HW support UNII-1
- b. It is unknown if Device A and Device B are indoor or outdoor

**Resulting use case restrictions:**

6. Since Device A and B are not connected to AP on UNII-1 band they may be outdoor. As such they cannot establish a connection on UNII-1 band and can only communicate on the low band channels or UNII-3 in specific regions.
7. Since 2.4GHz band is usually very busy with other WiFi communication and other technologies (BT, Microwave...) the communication may be slow and not stable.
8. The restriction on outdoor operation blocks valid indoor usages since, even where both Device A and Device

B are indoors, none of them can establish a GO on the indoor band and they must communicate on other bands.



**Case 4: We are the media center and cannot establish a GO on UNII-1 band due to any of the reasons described in previous use cases, even though we are indoors**

Use Case:

- Indoor AP established BSS on UNII-1
- Device A
  - associated with AP
  - capable of WFD
- Device B:
  - Battery powered device that support WFD and is not connected to the AP



- Device B wishes to establish a direct peer-to-peer link with Device A for file transfer (pictures)
- Device C:
  - AC Powered TV that is not connected to the AP
- Device A wishes to establish a direct peer-to-peer link with Device C for Wireless display
- Device D
  - capable of WFD
- Device A wishes to establish a direct peer-to-peer link with Device D for file transfer

**Assumptions:**

- a. Device A,B,C,D HW support UNII-1
- b. It is unknown if Device A,B,C,D are indoor or outdoor

**Resulting use case restrictions:**

9. Since Device A has several peer to peer connections simultaneously, it is optional only if device A is the GO and devices B,C and D are connected to the same group. Since Device B,C,D are not connected to AP on UNII-1 band they may be outdoor. As such they cannot establish a connection on UNII-1 band and can only communicate on the low band channels or UNII-3 on specific regions.
10. Since 2.4GHz band is usually very busy with other WiFi communication and other technologies (BT, Microwave...) the communication may be slow and not stable.
11. The restriction on outdoor operation blocks valid indoor usages since, even where all 4 devices A,B,C and D are indoors, They cannot be on the same group and have simultaneous connection on UNII-1 band.
12. Since the TV is AC powered it is allowed to activate a GO on UNII-1 band, but if that will happen then Device A will be a WFD Client and the other devices (B and D) will not be able to connect to it, or they will be able to connect to it on a different group (that will probably be on the low band) causing a non-optimal connection that is both on the low band and use different channels operation that split each channel time.

